

WHAT IS CLAIMED IS:

- 1 1. A device comprising:
2 a first substrate having a surface, said surface comprising a recognition
3 moiety;
4 a mesogenic layer oriented on said surface; and
5 an interface between said mesogenic layer and a member selected from
6 the group consisting of gases, liquids, solids and combinations thereof.
- 1 2. The device according to claim 1, wherein said recognition moiety is attached
2 to said surface by an interaction which is a member selected from the group
3 consisting of covalent bonding, ionic bonding, chemisorption, physisorption and
4 combinations thereof.
- 1 3. The device according to claim 1, wherein said surface further comprises an
2 organic layer.
- 1 4. The device according to claim 1, wherein said recognition moiety is attached
2 to said organic layer by an interaction which is a member selected from the group
3 consisting of covalent bonding, ionic bonding, chemisorption, physisorption and
4 combinations thereof.
- 1 5. The device according to claim 1, wherein said mesogenic layer comprises a
2 polymeric mesogen.
- 1 6. The device according to claim 1, wherein said interface is between said
2 mesogenic layer and air.
- 1 7. A device comprising:
2 a first substrate having a surface;
3 a second substrate having a surface, said first substrate and said second
4 substrate being aligned such that said surface of said first substrate opposes said
5 surface of said second substrate;

6 a first organic layer attached to said surface of said first substrate,
7 wherein said first organic layer comprises a first recognition moiety; and
8 a mesogenic layer between said first substrate and said second
9 substrate, said mesogenic layer comprising a plurality of mesogenic compounds.

1 8. The device according to claim 7, wherein at least one of said first substrate
2 and said second substrate further comprise a metal film.

1 9. The device according to claim 8, wherein said metal film is a member selected
2 from the group consisting of gold film, platinum film, palladium film, copper film,
3 nickel film, silver film and combinations thereof.

1 10. The device according to claim 7, further comprising a second organic layer
2 attached to said second substrate.

1 11. The device according to claim 10, wherein said second organic layer
2 comprises a second recognition moiety.

1 12. The device according to claim 10, wherein said first recognition moiety and
2 said second recognition moiety are the same.

1 13. The device according to claim 11, wherein said first recognition moiety and
2 said second recognition moiety are different.

1 14. The device according to claim 7, wherein said first substrate and said second
2 substrate are members independently selected from the group consisting of rigid
3 substrates, flexible substrates, optically opaque substrates, optically transparent
4 substrates, insulating substrates, conducting substrates, semiconducting substrates
5 and combinations thereof.

1 15. The device according to claim 14, wherein said first substrate and said second
2 substrate are members independently selected from the group consisting of
3 inorganic crystals, inorganic glasses, inorganic oxides, metals, organic polymers
4 and combinations thereof.

- 1 16. The device according to claim 16, wherein at least one of said first substrate
2 and said second substrate comprise an organic polymer which is a member
3 selected from the group consisting of permeable polymers, impermeable polymers
4 and combinations thereof.
- 1 17. The device according to claim 16, wherein said organic polymer is permeable
2 and is a member selected from the group consisting of cellulosic materials,
3 polyvinylidene fluoride, polydimethylsiloxane, track etched polycarbonate and
4 combinations thereof.
- 1 18. The device according to claim 16, wherein said at least one of said first
2 substrate and said second substrate further comprise at least one permeable metal
3 film.
- 1 19. The device according to claim 18, wherein said at least one permeable metal
2 film is a member selected from the group consisting of nickel film, copper film,
3 silver film, gold film, platinum film, palladium film and combinations thereof.
- 1 20. The device according to claim 19, wherein said at least one permeable metal
2 film is a gold film.
- 1 21. The device according to claim 20, wherein said gold film is an obliquely
2 deposited gold film.
- 1 22. The device according to claim 18, wherein said at least one permeable metal
2 film is of a thickness between about 0.01 nanometers and about 10 nanometers.
- 1 23. The device according to claim 22, wherein said at least one permeable metal
2 film is of a thickness between about 1 nanometer and 10 nanometers.
- 1 24. The device according to claim 7, wherein said surface of said first substrate
2 and said surface of said second substrate are members independently selected
3 from the group consisting of rough surfaces, substantially smooth surfaces,
4 patterned surfaces and combinations thereof.

- 1 25. The device according to claim 24, wherein said patterned surface is produced
2 by a method which is a member selected from the group consisting of grooving,
3 photolithography, photoetching, chemical etching, mechanical etching,
4 microcontact printing and combinations thereof.
- 1 26. The device according to claim 24, wherein said pattern comprises features
2 having a size of from about 1 micrometer to about 1 millimeter.
- 1 27. The device according to claim 26, wherein said pattern comprises features
2 having a size of from about 200 nanometers to about 10 micrometers.
- 1 28. The device according to claim 24, wherein said pattern comprises at least one
2 feature which is a member selected from the group consisting of wells, enclosures,
3 partitions, recesses, inlets, outlets, channels, troughs, diffraction gratings and
4 combinations thereof.
- 1 29. The device according to claim 28, wherein said at least one feature is a
2 plurality of wells, wherein each member of said plurality of wells is fluidically
3 isolated from the other members of said plurality of wells.
- 1 30. The device according to claim 29, wherein each member of said plurality of
2 wells comprises a depression and at least one border, wherein said border extends
3 vertically above said depression and said border comprises a compound which is a
4 member selected from the group consisting of hydrophobic compounds,
5 hydrophilic compounds and charged compounds.
- 1 31. The device according to claim 24, wherein said patterned surface anchors said
2 mesogenic layer.
- 1 32. The device according to claim 7, wherein said organic layer comprises a
2 member selected from the group consisting of organothiols, organosilanes,
3 amphiphilic molecules, cyclodextrins, polyols, fullerenes and biomolecules.

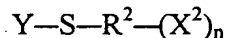
5 heteroarylalkyl, heterocyclic, substituted heterocyclic and heterocyclicalkyl
6 groups.

1 40. The device according to claim 38, wherein R¹ comprises a moiety which is a
2 member selected from group consisting of disulfide, ester, imide, carbonate,
3 nitrobenzyl, phenacyl and benzoin groups.

1 41. The device according to claim 38, wherein R¹ is a member selected from the
2 group consisting of alkyl and substituted alkyl groups.

1 42. The device according to claim 36, wherein X¹ is a member selected from the
2 group consisting of carboxylic acid, carboxylic acid derivatives, hydroxyl,
3 haloalkyl, dienophile, carbonyl, sulfonyl halide, thiol, amine, sulfhydryl, alkene
4 and epoxide groups.

1 43. The device according to claim 7, wherein said organic layer comprises a
2 member selected from the group consisting of:



4 wherein R is an alkyl group;

5 R² is a linking group between sulfur and X²;

6 X² is a member selected from the group consisting of reactive groups
7 and protected reactive groups;

8 Y is a member selected from the group consisting of H, R³ and
9 R³-S-;

10 R³ is a member selected from the group consisting of alkyl,
11 substituted alkyl, aryl, arylalkyl, substituted aryl, substituted arylalkyl,
12 saturated cyclic hydrocarbon, unsaturated cyclic hydrocarbon, heteroaryl,
13 heteroarylalkyl, substituted heteroaryl, substituted heteroarylalkyl,
14 heterocyclic, substituted heterocyclic and heterocyclicalkyl groups; and
15 n is a number between 1 and 50.

1 44. The device according to claim 43, wherein Y is a member selected from
2 the group consisting of H, methyl and ethyl groups.

1 45. The device according to claim 43, wherein R² is a member selected from the
2 group consisting of stable linking groups and cleaveable linking groups.

1 46. The device according to claim 43, wherein R² is a member selected from the
2 group consisting of alkyl, substituted alkyl, aryl, arylalkyl, substituted aryl,
3 substituted arylalkyl, saturated cyclic hydrocarbon, unsaturated cyclic
4 hydrocarbon, heteroaryl, heteroarylalkyl, substituted heteroaryl, substituted
5 heteroarylalkyl, heterocyclic, substituted heterocyclic and heterocyclicalkyl
6 groups.

1 47. The device according to claim 45, wherein R² comprises a cleaveable moiety
2 which is a member selected from group consisting of disulfide, ester, imide,
3 carbonate, nitrobenzyl, phenacyl and benzoin groups.

1 **48.** The device according to claim 45, wherein R² is a member selected from the
2 group consisting of alkyl and substituted alkyl groups.

1 49. The device according to claim 43, wherein X² is a member selected from the
2 group consisting of carboxylic acid, carboxylic acid derivatives, hydroxyl,
3 haloalkyl, dienophile, carbonyl, sulfonyl halide, thiol, amine, sulfhydryl, alkene
4 and epoxide groups.

1 50. The device according to claim 7, wherein said recognition moiety is attached
2 to said first substrate by a spacer arm.

1 **51.** The device according to claim 50, wherein said spacer arm comprises a
2 member selected from the group consisting of poly(ethyleneglycol),
3 poly(propyleneglycol), diamines and surface-active agents.

1 52. The device according to claim 7, wherein said first organic layer further
2 comprises a monovalent moiety.

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1 53. The device according to claim 7, wherein said recognition moiety comprises a
2 member selected from the group consisting of organic functional groups, metal
3 chelates, organometallic compounds and combinations thereof.

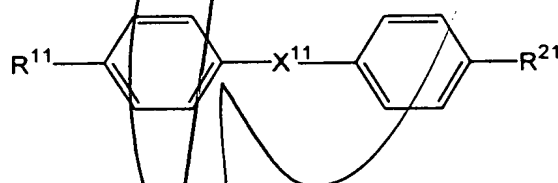
1 54. The device according to claim 53, wherein said organic functional group is a
2 member selected from the group consisting of amines, carboxylic acids, drugs,
3 chelating agents, crown ethers, cyclodextrins and combinations thereof.

1 55. The device according to claim 7, wherein said recognition moiety is biotin.

1 56. The device according to claim 7, wherein said recognition moiety is a
2 biomolecule.

1 57. The device according to claim 56, wherein said biomolecule is a member
2 selected from the group consisting of antibodies, nucleic acids, peptides, enzymes
3 and receptors.

1 58. The device according to claim 7, wherein said mesogenic layer comprises at
2 least one compound having a structure:

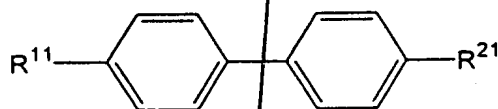


4 wherein,

5 R^{11} and R^{21} are members independently selected from the group
6 consisting of alkyl groups, lower alkyl, substituted alkyl groups, aryl groups, acyl
7 groups, halogens, hydroxy, cyano, amino, alkoxy, alkylamino, acylamino,
8 thioamido, acyloxy, aryloxy, aryloxyalkyl, mercapto, thia, aza, oxo, both saturated
9 and unsaturated cyclic hydrocarbons, heterocycles, arylalkyl, substituted aryl,
10 alkylhalo, acylamino, mercapto, substituted arylalkyl, heteroaryl, heteroarylalkyl,
11 substituted heteroaryl, substituted heteroarylalkyl, substituted heterocyclic and
12 heterocyclicalkyl; and

13 X¹¹ is a member selected from the group consisting of —C=N—, —
14 N=N(O)—, C=N(O)—, —HC=CH—, —C≡C— and —OC(O)—

1 59. The device according to claim 7, wherein said mesogenic layer comprises at
2 least one compound having a structure:



3
4 wherein,

5 R¹¹ and R²¹ are members independently selected from the group
6 consisting of alkyl groups, lower alkyl, substituted alkyl groups, aryl groups, acyl
7 groups, halogens, hydroxy, cyano, amino, alkoxy, alkylamino, acylamino,
8 thioamido, acyloxy, aryloxy, aryloxyalkyl, mercapto, thia, aza, oxo, both saturated
9 and unsaturated cyclic hydrocarbons, heterocycles, arylalkyl, substituted aryl,
10 alkylhalo, acylamino, mercapto, substituted arylalkyl, heteroaryl, heteroarylalkyl,
11 substituted heteroaryl, substituted heteroarylalkyl, substituted heterocyclic and
12 heterocyclicalkyl groups.

1 60. A device according to claim 7, wherein said mesogenic layer comprises a
2 mesogen which is a member selected from the group consisting of 4-cyano-4'-
3 pentylbiphenyl, N-(4-methoxybenzylidene)-4-butylaniline and combinations
4 thereof.

1 61. The device according to claim 7, wherein said mesogenic layer is a patterned
2 mesogenic layer.

1 62. The device according to claim 7, wherein said mesogenic layer is a non-
2 planar mesogenic layer.

1 63. The device according to claim 7, wherein said mesogenic layer is tunable.

- 1 64. The device according to claim 63, wherein said device is tunable by the
2 application of at least one electrical field.
- 1 65. The device according to claim 63, wherein said device affects light
2 impinging upon it in a manner which is a member selected from the group
3 consisting of refractive, diffractive and combinations thereof.
- 1 66. A device for detecting an interaction between an analyte and a
2 recognition moiety, said device comprising:
3 a first substrate having a surface;
4 a second substrate having a surface, said first substrate and said second
5 substrate being aligned such that said surface of said first substrate opposes said
6 surface of said second substrate;
7 a first organic layer attached to said surface of said first substrate,
8 wherein said organic layer comprises a first recognition moiety which interacts with
9 said analyte; and
10 a mesogenic layer between said first substrate and said second
11 substrate, said mesogenic layer comprising a plurality of mesogens, wherein at least
12 a portion of said plurality of mesogens undergo a detectable switch in orientation
13 upon interaction between said first recognition moiety and said analyte, whereby said
14 presence of said analyte is detected.
- 1 67. The device according to claim 66, wherein said analyte is a member
2 selected from the group consisting of acids, bases, organic ions, inorganic ions,
3 pharmaceuticals, herbicides, pesticides, chemical warfare agents, noxious gases,
4 biomolecules and combinations thereof.
- 1 68. The device according to claim 66, wherein said interaction is a member
2 selected from the group consisting of covalent bonding, ionic bonding,
3 hydrogen bonding, van der Waals interactions, repulsive electronic
4 interactions, attractive electronic interactions, hydrophobic interactions,
5 hydrophilic interactions and combinations thereof.

1 69. The device according to claim 67, wherein said interaction is an ionic
2 interaction and the analyte is a member selected from the group consisting of
3 acids, bases, metal ions and metal ion binding ligands.

3 ~~70. The device according to claim 67, wherein said analyte is a nucleic acid and
said interaction is a hydrogen bonding interaction between said nucleic acid and
a strand having an at least partially complementary sequence.~~

1 71. The device according to claim 70, wherein said interaction is between a
2 protein and a small molecule.

1 72. The device according to claim 71, wherein said interaction is between an
2 enzyme and a substrate for said enzyme.

1 73. The device according to claim 71, wherein said interaction is between an
2 antibody and a complementary antigen.

1 74. The device according to claim 71, wherein said interaction is between biotin
2 and avidin.

1 75. The device according to claim 71, wherein said interaction is between biotin
2 and an antibiotin antibody.

1 76. A method for detecting an analyte, comprising:

2 (a) contacting with said analyte a recognition moiety for said analyte, wherein
3 said contacting causes at least a portion of a plurality of mesogens proximate to said
4 recognition moiety to detectably switch from a first orientation to a second orientation
5 upon contacting said analyte with said recognition moiety; and

6 (b) detecting said second configuration of said at least a portion of said
7 plurality of mesogens, whereby said analyte is detected.

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- 1 77. The method according to claim 76, wherein said analyte is a member
2 selected from the group consisting of vapors, gases and liquids.
- 1 78. The method according to claim 77, wherein said vapor is a member selected
2 from the group consisting of vapors of a single compound and vapors of a
3 mixture of compounds.
- 1 79. The method of claim 77, wherein said gas is a member selected from the
2 group consisting of a single gaseous compound and mixtures of gaseous
3 compounds.
- 1 80. The method of claim 77, wherein said liquid is a member selected from the
2 group consisting of a single liquid compound, mixtures of liquid compounds,
3 solutions of solid compounds and solutions of gaseous compounds.
- 1 81. The method according to claim 76, wherein said recognition moiety
2 comprises a member selected from the group consisting of metal ions, metal-
3 binding ligands, metal-ligand complexes, nucleic acids, peptides, cyclodextrins,
4 acids, bases, antibodies, enzymes and combinations thereof.
- 1 82. The method according to claim 76, wherein from about 10^3 to about 10^8
2 mesogens undergo said switching for each molecule of analyte interacting with
3 said analyte.
- 1 83. The method according to claim 76, wherein from about 10^3 to about 10^6
2 mesogens undergo said switching.
- 1 84. The method according to claim 76, wherein said first orientation is a member
2 selected from the group consisting of uniform, twisted, isotropic and nematic
3 and said second orientation is a member selected from the group consisting of
4 uniform, twisted, isotropic and nematic, with the proviso that said first
5 orientation and said second orientation are different orientations.

- 1 85. The method according to claim 84, wherein said detecting is achieved by a
2 method selected from the group consisting of visual observation, microscopy,
3 spectrometry, electronic techniques and combinations thereof.
- 1 86. The method according to claim 84, wherein said visual observation detects a
2 change in reflectance, transmission, absorbance, dispersion, diffraction,
3 polarization and combinations thereof, of light impinging on said plurality of
4 mesogens.
- 1 87. The method according to claim 85, wherein said microscopy is a member
2 selected from the group consisting of light microscopy, polarized light
3 microscopy, atomic force microscopy, scanning tunneling microscopy and
4 combinations thereof.
- 1 88. The method according to claim 85, wherein said spectroscopic technique is a
2 member selected from the group consisting of infrared spectroscopy, raman
3 spectroscopy, x-ray spectroscopy, visible light spectroscopy, ultraviolet
4 spectroscopy and combinations thereof.
- 1 89. The method according to claim 85, wherein said electronic technique is a
2 member selected from the group consisting of surface plasmon resonance,
3 ellipsometry, impedometric methods and combinations thereof.
- 1 90. A device for synthesizing and screening a library of compounds, comprising:
2 (1) a synthesis component, comprising:
3 (a) a first substrate having a surface;
4 (b) a self-assembled monolayer on said surface, said
5 monolayer comprising a reactive functionality; and
6 (2) an analysis component, comprising:
7 (a) a second substrate having a surface; and

(b) a mesogenic layer between said surface of said first substrate and said surface of said second substrate.

91. The device according to claim 90, further comprising a second self-assembled monolayer attached to said surface of said second substrate.

92. The device according to claim 90, wherein said second substrate is permeable to an analyte being in a physical state which is a member selected from the group consisting of liquids, gases and vapors.

93. The device according to claim 90, wherein a member selected from said first substrate, said second substrate and both said first substrate and said second substrate further comprises a metal film.

94. The device according to claim 90, wherein said metal film is a member selected from the group consisting of gold, nickel, copper, palladium, platinum and silver.

95. The device according to claim 95, wherein a member selected from the group consisting of said first substrate, said second substrate and both said first and said second substrate is patterned.

96. The device according to claim 95, wherein said member is patterned into a plurality of wells.

97. The device according to claim 90, wherein said self-assembled monolayer comprises a member selected from the group consisting of alkanethiols, functionalized alkanethiols and combinations thereof.

98. The device according to claim 90, wherein said functionalized alkanethiol is a member selected from the group consisting of $R^{21}CH_2(CH_2)_{14}SH$ and $R^{31}CH_2(CH_2)_{15}SH$, wherein R^{21} and R^{31} are members independently selected from the group consisting of reactive groups and recognition moieties.

1 99. The device according to claim 90, wherein said first monolayer is patterned.

1 100. The device according to claim 90, wherein said first monolayer is
2 patterned into a plurality of wells.

1 101. The device according to claim 90, wherein said mesogenic layer
2 comprises a member selected from the group consisting of 4-cyan0-4'-
3 pentylbiphenyl, N-(4-methoxybenzylidene)-4-buty laniline and combinations
4 thereof.

1 102. A method for synthesizing and analyzing a combinatorial library of
2 compounds using the device of claim 90, said method comprising:

- 3 (a) adding a first component of a first compound to a first region of
4 said surface of said first substrate and a first component of a
5 second compound to a second region of said surface of said first
6 substrate;
7 (b) adding a second component of said first compound to said first
8 region of said surface of said first substrate and adding a second
9 component of said second compound to said second region on said
10 surface of said first substrate;
11 (c) reacting said first and second components to form a first product
12 and a second product;
13 (d) applying said mesogenic layer to said surface of said first substrate;
14 (e) adding an analyte to said first region and said second region; and
15 (f) detecting said switch in said mesogenic layer from a first
16 orientation to said second orientation, whereby said analyzing is
17 achieved.

1 103. The method according to claim 102, wherein a library having more
2 than 10 compounds is synthesized.

1 104. The method according to claim 103, wherein a library having more
2 than 100 compounds is synthesized.

1 105. The method according to claim 104, wherein a library of more than
2 1,000 compounds is synthesized.

1 106. A library of compounds synthesized on a self-assembled monolayer.

1 107. The library according to claim 106, wherein said self-assembled
2 monolayer comprises a member selected from the group consisting of
3 alkanethiols, functionalized alkanethiols and combinations thereof.

1 108. A method of amplifying an interaction between a first molecule and a
2 second molecule and transducing said interaction into an optical signal, said
3 method comprising:
4 inducing a rearrangement in a conformation of a mesogenic layer
5 associated with a self-assembled monolayer, wherein said rearrangement is induced
6 by interacting said first molecule with said second molecule, said first molecule being
7 a component of said self-assembled monolayer.

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